(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 143 749 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(43) Date of publication:
10.10.2001 Bulletin 2001/41

(21) Application number: **98960993.8**

(22) Date of filing: **23.12.1998**

(51) Int Cl.[7]: **H04Q 7/20**

(86) International application number:
PCT/CN98/00314

(87) International publication number:
WO 00/40042 (06.07.2000 Gazette 2000/27)

(84) Designated Contracting States:
BE DE FI FR GB NL SE

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(54) FUZZY CHANNEL ALLOCATION CONTROLLER HAVING SERVICE QUALITY INSURING

(57) A fuzzy channel allocation controller assuring a quality of service and used in a hierarchical wireless communication system. A system with the fuzzy channel allocation controller is provided, and a threshold for allowing a call entering into the system is adaptively adjusted according to system condition so that the calls are sustained in a predetermined quality. Furthermore, in allocating channels, the loads of the macro cell and micro cells are balanced so that the system has a higher channel utility. This system having a macro cell and a plurality of micro cells which includes a base station interface module, a resource estimator, and a performance estimator and a fuzzy channel allocation processor.

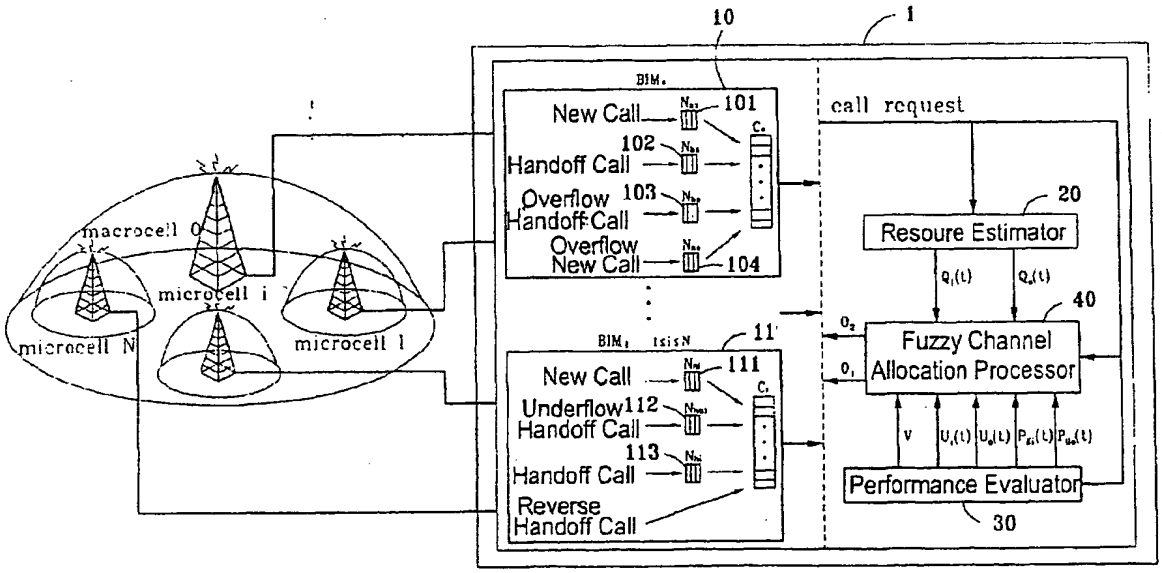

FIG. 1

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EP 1 143 749 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a fuzzy channel allocation controller. A threshold for allowing a call entering into the system is adaptively adjusted so that the calls are sustained in a predetermined quality.

BACKGROUND OF THE INVENTION

[0002] With the increasing development of wireless communication, wireless communication has become more and more important in the human daily life. The frequency spectrum is an important resource in the wireless communication. How to use the spectrum resource effectively so as to increase the system capacity and quality of service is a critical problem in wireless technology.

[0003] In the conventional channel allocation, methods for sustaining quality of service in handoff calls is to leave part of channels to the handoff calls having a higher priority. While how many channels are required to be left so as to sustain quality of service and to cause the utility of channels achieves an optimum level is a key problem. It is often that a system with a random variation of loads is very difficult since the complexities of the system module and mathematical deduction. The fuzzy channel allocation controller of the present invention has got a result from a system simulation. Comparing with the conventional channel allocation ways, the fuzzy channel allocation controller of the present invention substantially sustains the quality of service and has a higher utility of channels.

SUMMARY OF THE INVENTION

[0004] Accordingly, the primary object of the present invention is to provide a fuzzy channel allocation controller. A threshold for allowing a call entering into the system is adaptively adjusted according to system condition so that the calls are sustained in a predetermined quality. Furthermore, in allocating channels, the loads of the macro cell and micro cells are balanced so that the system has a higher channel utility.

[0005] To achieve above objects, the present invention provides a fuzzy channel allocation controller which includes a base station interface module, a resource estimator, a performance estimator and a fuzzy channel allocation processor. The base station interface module provides an interface circuit to interface with a base station, and provides separated buffers for registering calls temporarily. The function of the resource estimator is to calculate effective resource as a call occurs, which includes space channels and buffers; and the function of the performance estimator is to adaptively estimate performance of the system.

[0006] The various objects and advantages of the present invention will be more readily understood from the following detailed description when read in conjunction with the appended drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Fig. 1 is the system construction of fuzzy channel allocation controller assuring a quality of service and used in a hierarchical wireless communication system in the present invention.

Fig. 2 is a functional block of fuzzy channel allocation controller assuring a quality of service and used in a hierarchical wireless communication system in the present invention.

Fig. 3 is a basic function block view of fuzzy channel allocation controller assuring a quality of service and used in a hierarchical wireless communication system in the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] In a fuzzy channel allocation controller, a complete-partitioning buffer serves to register calls not being stored due to no dummy channel for reducing the failure of calling and enhancing quality of service.

[0009] In the present invention, a fuzzy channel allocation controller with an assurance of quality of service. Referring to Fig. 1, the fuzzy channel allocation controller of the present invention includes a base station interface module 10 (BIM), a resource estimator 20, a performance estimator 30 and a fuzzy channel allocation processor 40. The base station interface module 10 has a plurality of buffers for being used by various calls. A macro cell has Nna buffers 101 for new calls, Nha buffers 102 for handoff calls from proximate macro cells, and Nho buffers for the overflow handoff calls of a micro cell. Ith base station interface module 10 provides Nni buffers for new calls in the micro cells. Nhui buffers 112 serves for the underflow handoff calls of a macro cell. Nhi buffers 113 serves for the handoff calls of prox-

imate micro cells. Besides, when dummy channels 114 exist in one micro cell, the calling reverse flow being executing in a macro cell is allowable to be handoff to the channels of micro cells. This way may reduce the call jam and balance the loads on the system.

[0010] The resource estimator 20 30 calculates effective performance QO(t) and Qi(t) of the micro cells and macro cells. The effective resource includes dummy channels and buffers. The performance estimator 30 calculates the failure rate PHO(t) and Phi(t), channel utility of the macro cell and micro cells U0(t) and Ui(t), and estimation (v) of moving customer. The outputs of the fuzzy channel allocation processor is Q1 and Q2. The following table lists the means of Q1 and Q2:

Q1	Q2	Meanings
0	0	Using macro cell channel to allocating calls
0	1	Using micro cell channel to allocating calls
1	0	Reject calls to enter into a system
1	1	Reject calls to enter into a system

[0011] In the operation of the fuzzy channel allocation controller, the base station interface module 10 provides resources to various calls. The resource estimator 20 and the performance estimator 30 acquires adaptive information from the system to calculate effective resources and performance estimate of the system adaptives, and then, this message is sent to the fuzzy channel allocation processor 40. Then, the fuzzy channel allocation processor acquires the call allowable threshold and fuzzy channel allocation control message by a fuzz induction through fuzzy rule and a database according to the received message. Then, the system determines whether to receive a request for allow a call to enter into the system and which channel is desired to allocated to the call according to the call allowable threshold and fuzzy channel allocation control message. If the system has determined to accept the request, then the following allocation way is allowable:

1. If the new call or handoff call only occurs in the coverage of a macro cell, then the channel of the macro cell is allocated to this call.
2. When the new call or handoff call occurs in the overlapping area of a micro cell and a macro cell, then a channel of the micro cell is allocated to this call or this call is overflowed to the macro cell to used the channel of the macro cell.
3. If the current call in adjacent macro cell is handoff to the overlapping area of the micro cell and macro cell, a channel of the micro cell can be allocated to this handoff call, or the handoff call is underflowed to the micro cell to use the channel of the micro cell.
4. To increase the utility of the micro cell, the call in the macro cell can be reversed to the micro cell.

As shown in Fig. 2, the fuzzy channel allocation processor 40 is designed by a concept of fuzz multiple layer logic control way for facilitating the complexity of the structure. In the present invention, a two layer fuzz logic controller is used. The first layer is a fuzz allowable call threshold estimator 401 and the second layer is a fuzzy channel allocation controller 402. The fuzz allowable call threshold estimator 401 has variables of handoff call failure rate and available resource and a Sugeno displacement gradient way is used to adjust the call threshold so as to allow the threshold HO(t+1) and Hi(t+1), where "t" represents the new call period, and "t+1" represents next time for generating a call. This call threshold is provided to the second layer, which is used as the fuzzy channel allocation controller allocates fuzzy channels. In the second layer, the fuzzy channel allocation controller 402 has the input variables of handset moving speed, channel utility and avail resource. The functions thereof is used in the fuzzy channel allocation for increasing the utility of the channels. The methods for allocating channels in the fuzzy channel allocation controller of the present invention and the prior art have been compared through system simulation, it has proved that the fuzzy channel allocation controller of the present invention substantially sustains the quality of service and has a higher channel utility.

[0012] The fuzzy channel allocation controller of the present invention formed by a two layer fuzzy logic controller. The interior of the fuzzy logic controller is illustrated in Fig. 3, wherein the input message (X) is fuzzized to become language parameters (step 50), and is obtained from deduction (step 60). In that deduction, professional knowledge is required to built the deduction rule data (step 70) as a basis in that deduction. Finally, the acquired language result from the deduction is fuzzized (step 80) to be as an output control signal (Y).

[0013] Since the present invention is according to the deduction rule database according to fuzz principle and professional knowledge and a two layer control way is used to reduce the complexity in design. Therefore, the fuzzy logic

controller has the following two functions:

1. The call allowable threshold can automatically adjust the function of estimation. This function is primarily set the threshold of the call allowable to enter into the system. The higher the threshold, the lower the possibility for being allowed to enter into the system. If the setting of a new call is different from that of a current handoff call, then different priorities can be identified. In general, the executing handoff call is set with a lower threshold for protecting an executing macro cell now.
2. Fuzzy channel allocation function: in that, the input variable is an available resource which is the sum of moving speed of a handset, available channel numbers, and number of dummy buffers. Then, a min-max deduction method is used as a deduction basis of fuzzy channel allocation. The final result represents whether the call is accepted or is allowable to use the effective resource in the macro cell or micro cell.

The present invention has the following advantages:

1. In the design concept of the fuzzy channel allocation controller, a separable buffer is used to register calls which has no channel allocated temporarily so as to reduce the rate of failure and increase the quality of service of the system.
2. The separable buffer in the fuzzy channel allocation controller make the system can be managed easily, effectively and conveniently.
3. In the design concept of the FCAP, a fuzzy multiple layer logic controller is used for facilitating the complexity in design. In this design, a two layer fuzzy logic control is used so that the design can be facilitated and the complex channel allocation problem.
4. The first layer of the fuzzy channel allocation processor is a fuzzy call allowable threshold estimator which has the function of adaptively adjusting call threshold. Thus, it can be operated in a system with a random processing load. In the fuzzy deduction method, a Sugeno displacement gradient way is used to adaptively adjust the call threshold.
5. Different allowable call threshold are used in different calls for achieving different call priority. For example, the allowable call threshold is set to be large than the allowable call threshold of handoff calls for achieving different priority.
6. The second layer of the fuzzy channel allocation processor is a fuzzy channel allocator. The input variables of the fuzzy channel allocator are selected from effective system messages.

For example, moving speed of a handset, available channel numbers, and number of dummy buffers. Then, a min-max deduction method is used as a deduction basis of fuzzy channel allocation. The final result represents whether the call is accepted or is allowable to use the effective resource in the macro cell or micro cell.

7. The fuzzy channel allocation processor is according to the fuzz theory, the decision of output is a soft decision.
8. The present invention has been proved that it can balance the channel utility between the micro cell and macro cell so as to achieve a higher channel utility higher than that in the prior art designs.
9. The quality of service is sustained.

[0014] The present invention is thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A fuzzy channel allocation controller assuring a quality of service and used in a hierarchical wireless communication system, this system having a macro cell and a plurality of micro cells which includes a base station interface module, a resource estimator, a performance estimator and a fuzzy channel allocation processor;
wherein the base station interface module provides an interface circuit to be interfaced with a base station, and provides separated buffers for registering calls temporarily; the function of the resource estimator is to calculate effective resource as a call occurs, which includes space channels and buffers; and the function of the performance estimator is to adaptively estimate performance of the system;
wherein in a system with the fuzzy channel allocation controller, a threshold for allowing a call entering into the system is adaptively adjusted according to system condition so that the calls are sustained in a predetermined quality; furthermore, in allocating channels, the loads of the macro cell and micro cells are balanced so that the system has a higher channel utility.

2. The fuzzy channel allocation controller assuring a quality of service as claimed in claim 1, wherein an interior of the base station interface module provides buffers to store different calls temporarily; in the macro cell, Nna buffers is provided for new calls, Nha buffers is provided for handoff calls from proximate macro cells, and Nho buffers is provided for the overflow handoff calls of a micro cell; Ith base station interface module provides Nni buffers for new calls in the micro cells; Nhui buffers is provided to the underflow handoff calls of a macro cell; Nhi buffers is provided for the handoff calls of proximate micro cells; besides, when dummy channels exist in one micro cell, the calling reverse flow being executing in a macro cell is allowable to be handoff to the channels of micro cells; this way reduces the call jam and balance the loads on the system.

3. The fuzzy channel allocation controller assuring a quality of service as claimed in claim 2, wherein the buffers in the base station interface module are separated buffers for storing calls not being stored in a dummy channel so as to reduce the rate of failure.

4. The fuzzy channel allocation controller assuring a quality of service as claimed in claim 3, wherein the fuzzy channel allocation processor is designed by a concept of fuzz multiple layer logic control way for facilitating the complexity of a structure, a two layer fuzz logic controller is used; a first layer is a fuzz allowable call threshold estimator and a second layer is a fuzzy channel allocation controller; a fuzz allowable call threshold estimator has variables of handoff call failure rate and available resource, and a Sugeno displacement gradient way is used to adjust the call threshold for achieving various priority; in the second layer, the fuzzy channel allocator has the input variables of effective messages; then a min-max deduction method as a deduction way of a fuzzy channel allocator, and the final result represents whether the call is accepted and whether it is allocated with effective resources in the macro cell or micro cells.

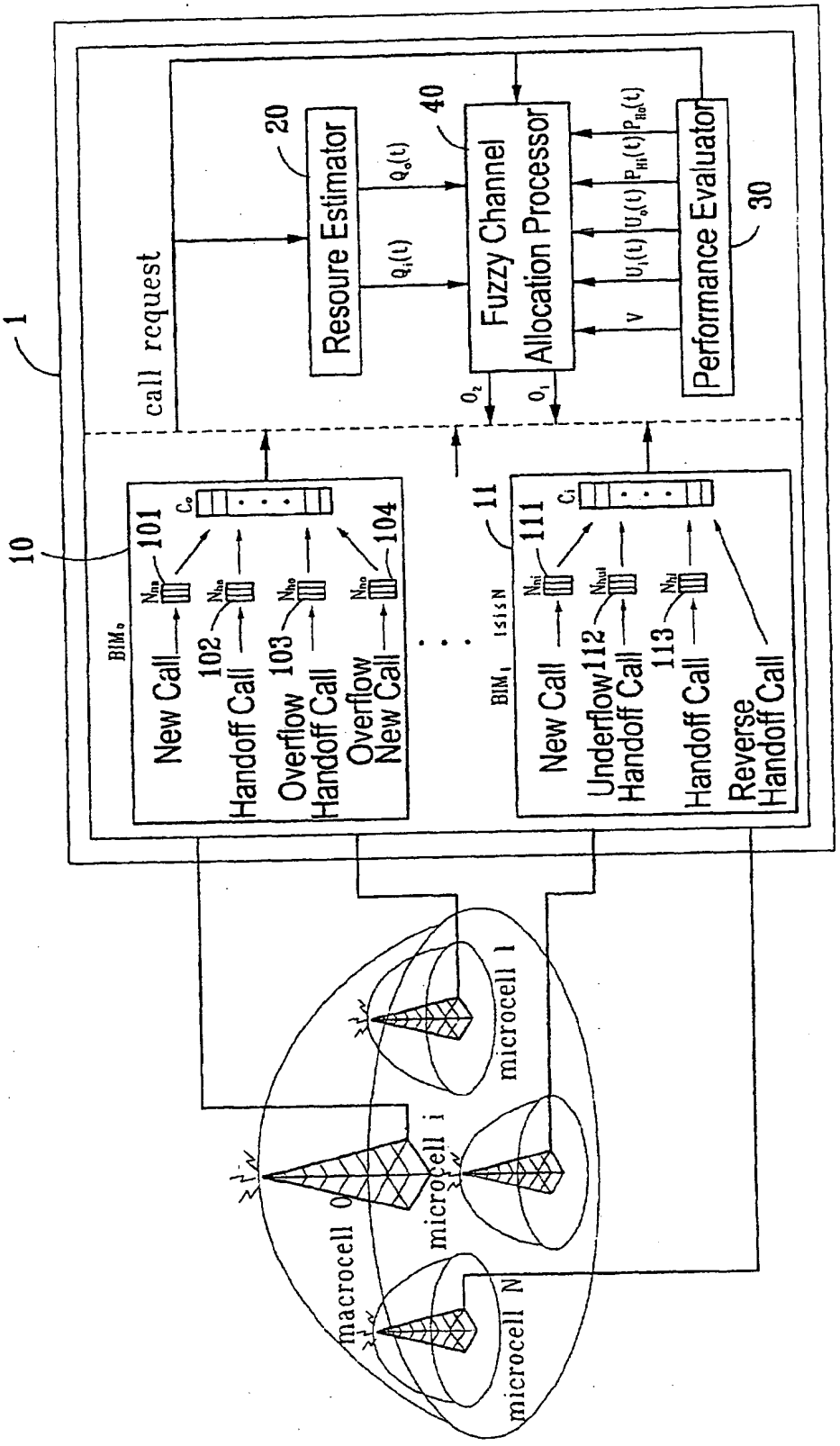
1
call request
20
Resoure Estimator
40
Fuzzy Channel Allocation Processor
30
Performance Evaluator
10
11
101
102
103
104
111
112
113
New Call
Handoff Call
Overflow Handoff Call
Overflow New Call
Underflow Handoff Call
Reverse Handoff Call
macrocell 0
microcell 1
microcell i
microcell N

FIG. 1

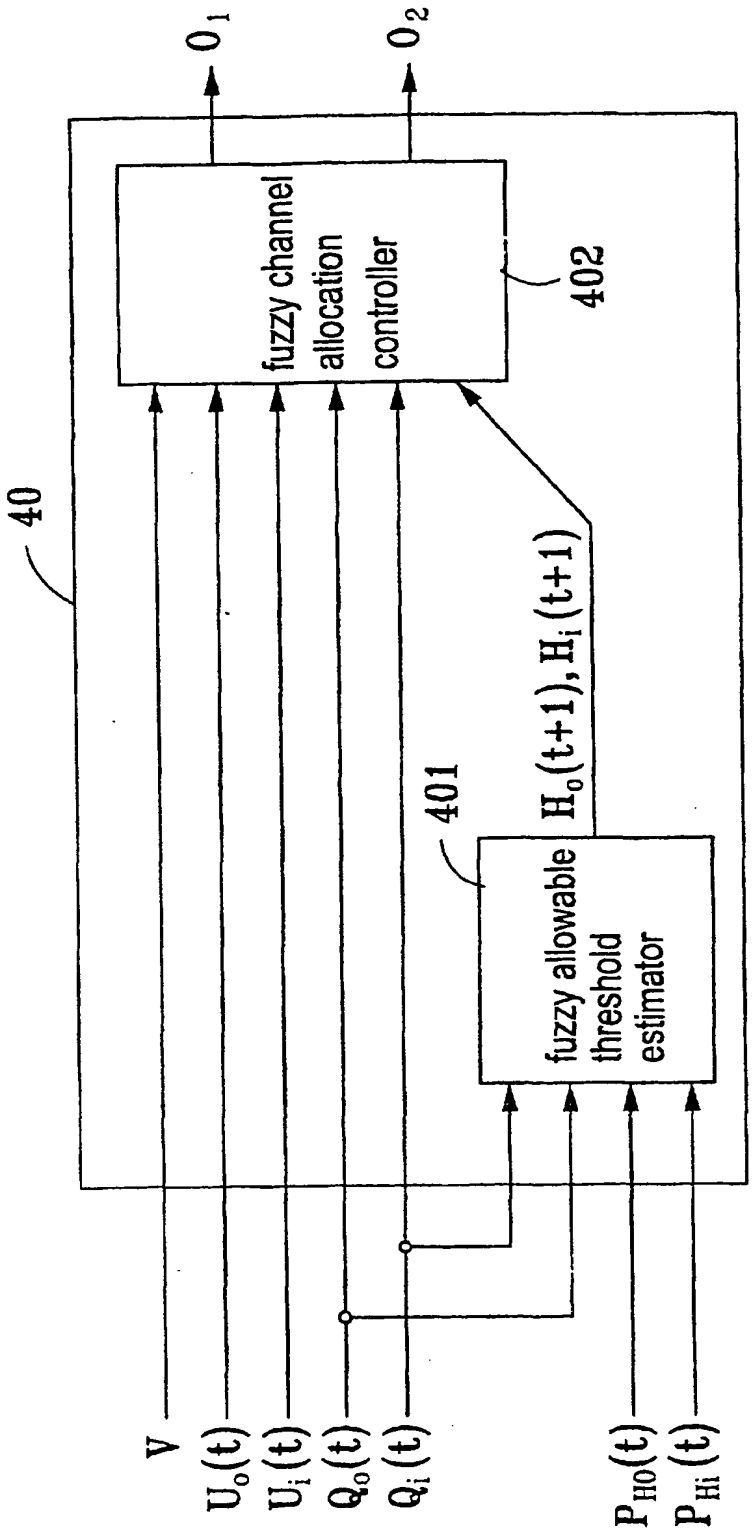

FIG. 2

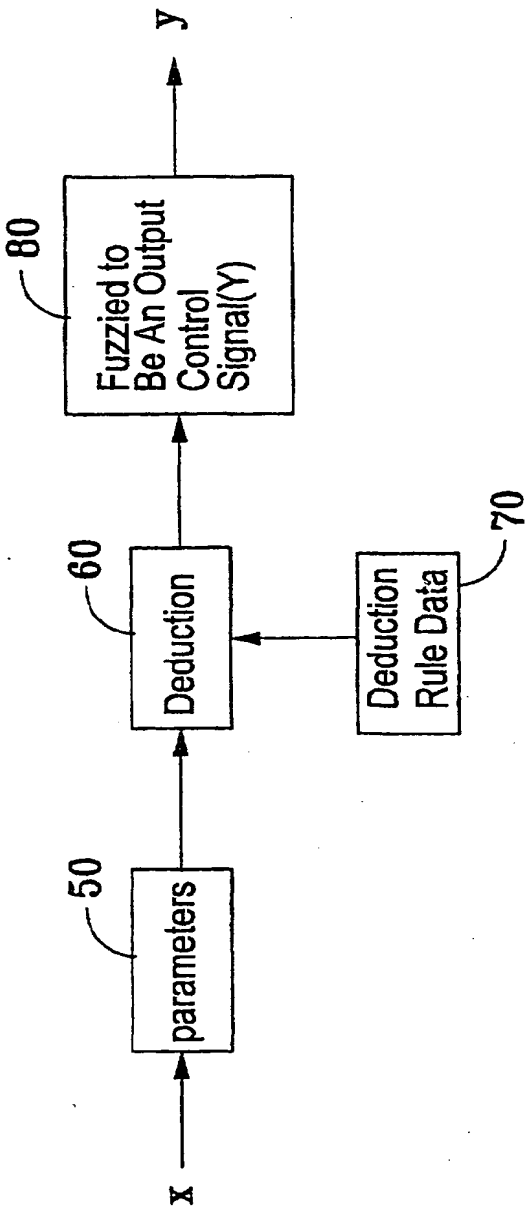

FIG.3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN98/00314

A. CLASSIFICATION OF SUBJECT MATTER

IPC6 H04Q 7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6 H04Q 7/20 H04Q 7/36 H04Q 7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC WPI PAJ CPOPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5774808A(Juha Sarkiojo et al.) 30.Jun.1998(30.06.98) See the whole document	1-4
A	CN 1181684A(KRONE AG) 13.May.1998(13.05.98) See the whole document	1-4
A	CN 1185890A(ERICSSON TELEFON AB L.M) 24.Jun.1998(24.06.98) See the abstract	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06.May.1999(06.05.99)	27 MAY 1999 (27.05.99)
Name and mailing address of the ISA/CN 6 Xitucheng Rd., Jimen Bridge, Haidian District, 100088 Beijing, China Facsimile No. 86-10-62019451	Authorized officer Telephone No. 86-10-62093193

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INTERNATIONAL SEARCH REPORT

Information patent family members

Search request No.
PCT/CN98/00314

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		EP 819362A	21.Jan.1998

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